

Western Electric Co., Incorporated,
Equipment Engineering Branch, Hawthorne.

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METHOD OF OPERATION

Schematic - Service Observing Circuit - For Panel and Step by Step Machine
Switching Offices.

DEVELOPMENT

1. PURPOSE OF CIRCUIT

1.1 This circuit is used for observing service in step-by-step or
power-driven machine switching offices.

2. WORKING LIMITS

2.1 This circuit will operate with subscribers' lines having a
maximum loop resistance of 750 ohms with a 10,000 ohm leak and a
maximum of 15 volts earth potential.

OPERATION

3. PRINCIPAL FUNCTIONS

The principal functions of this circuit are as follows:

3.01 To provide a visible signal when subscriber removes the re-
ceiver from the switchhook.

3.02 To record the dial pulses on a pen register.

3.03 To give a visible signal if subscriber dials before sender is
selected.

3.04 To give a visible signal when sender is selected.

3.05 To give a visible signal when line switch plunges in a step-
by-step office.

3.06 To give a visible signal when district is selected in a full
mechanical office.

3.07 To provide a means for disconnecting the pen register from
service.

3.08 To give a visible and an audible signal when coil collect or
coin return current is sent over the line.

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- 3.09 To give a visible and an audible signal when message register operates.
- 3.1 To indicate the time required for the selection of an idle sender.
- 3.2 To indicate the time which has elapsed when the first dial impulse is received.
- 3.3 To hold the line for talking between the operator and the subscriber and give a visible signal while line is held.
- 3.4 To provide a means for the operator to check the speed of the cycle counters.
- 3.5 To provide a means for releasing the observing circuit from the line at any time during a call.
- 3.6 To return to normal.

4. CONNECTING CIRCUITS

- 4.1 This circuit functions with line finder, and line switch circuits in power drive offices and primary line switch circuits in step-by-step offices.

DESCRIPTION OF OPERATION

OPERATION IN POWER DRIVE OFFICES

5. PRELIMINARY FUNCTIONS

When the plug of the service observer's receiver is inserted in the jack, the common ground lead is closed from the (REL) key, through the contacts of the (REL) relay, to the contacts of all the individual (L) relays. The receiver is also connected in series with the 23 ohm winding of the 27-F repeating coil for monitoring purposes.

RECEIVER REMOVED FROM SWITCHHOOK

6. LINE FINDER AND STEP-BY-STEP OFFICES

When the receiver is removed from the switchhook on a line which is connected for observation, the individual line relay and the (L) relay associated with the service observing line operate in series.

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The operation of the (L) relay operates the (YK) and (F) relays. Circuit:- Common ground, (L) relay operated, the (S) and (A) relays normal, 600 ohm winding of the (YK) relay, the (J) relay normal, the winding of the (F) relay to battery. The (YK) relay operated, (a) locks through its 800 ohm winding, in series with the winding of the (J) relay, to ground on the (REL) key normal, operating the (J) relay, (b) operates the (A) relay, (c) lights the (L) lamp, (d) connects ground through the 18-BL resistance and break contact of the (B) relay, in parallel with the windings of the (CC) and (CR) relays, 5-G or 40-M resistance, and 29 ohm winding of the 27-F repeating coil in series, to the tip of the subscriber's line, (e) connects the ring of the line to battery through the (B) relay normal, windings of the (C) relay, which operates, and (f) operates the (K) and (PR) relays in parallel to ground through the make contacts of the (YK) and (L) relays.

7. CALLS ORIGINATED SIMULTANEOUSLY

The (F) relay operated, (a) connects its non-inductive winding in parallel with its inductive winding, thereby making the relay slow to release, in order to prevent its release before the operation of the (A) and (J) relays, and (b) starts the cycle counters in operation. The (J) relay operated, closes a holding circuit for the (F) relay, from battery through the make contact and non-inductive winding of the (F) relay in parallel with its inductive winding, (J) relay operated, 600 ohm resistance, to ground on (REL) key normal, preventing the (F) relay from releasing as the (A) relay operates. The (J) relay operated, disconnects battery from the inner windings of all the (YK) relays, thereby preventing the operation of any of the relays in case a call is originated on another line which is connected for observation. In case two calls are originated simultaneously, the (YK) relay whose armature is connected through the break contact of another (YK) relay to the winding of the (J) relay releases when the (J) relay operates, while the (YK) relay whose holding circuit is not opened by the operation of the other (YK) relay holds as described above.

8. PRELIMINARY RELAY FUNCTIONS

The (A) relay operated, opens the circuit through the 600 ohm winding of the (YK) relay, and connects the winding of the (MR-1) relay ("B" wiring) in parallel with the message register in the subscriber's line circuit. The (PR) relay operated, operates the (H) relay, which locks to ground, under control of the (REL) and (CO) keys. The (K) relay operated, locks through the winding of the (M) relay, to ground through the break contact of the (REL) key, and operates the (HL) relay. Circuit:- Battery, through the 1200 ohm winding of the (HL) relay, the (K)

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relay operated, the (PT) and (D) relays normal to common ground through the contact of the (REL) key.

NOTE:- The (HL) relay can operate over two circuits, the one previously described and one through the make contact of the (C) relay. The (C) relay being a little slower in operating than the (K) relay, it is probable that the operating circuit for the (HL) relay is through the make contact of the (K) relay. (The (M) relay does not operate at this time as its winding is short-circuited). The (HL) relay operated, operates the (E) relay. Circuit:- Battery, the winding of the (E) relay, the (HL) relay operated, the (PT) relay normal, to common ground. The operation of the (E) relay, (a) closes a circuit from battery through its winding of the (D) relay, to common ground in which the (E) relay holds and the (D) relay operates as soon as the short circuit is removed from its winding, by the release of the (HL) relay, and (b) operates the (PT) relay. The (HL) relay now holds in a circuit through its 1200 ohm winding the (C) relay operated, the (D) relay normal, to common ground.

9. FAILURE OF (L) RELAY

Should the (L) relay fail to remain operated, a sufficient length of time to permit the (K) relay to fully operate, the (K) and (M) relays operate through the make contact of the (J) relay, and lock to the common ground.

10. LINE FOUND BEFORE SENDER IS SELECTED

When the line finder finds the line which has originated the call, battery is connected to the sleeve terminal, causing the operation of the line cut-off relay and the service observing (SL) relay, in parallel, ("Y" wiring). If a subscriber's line is an individual line or the last line of a PBX group, the (SL) relay operates through its windings in series, (PBX key normal) but if the subscriber's line is a PBX line other than the last in the group, the (SL) relay operates through its 8000 ohm winding (PBX key operated). The operation of the cut-off relay releases the individual line relay and also the service observing (L) relay if the sender has not at this time been selected. The (SL) relay operated, operates the (S) relay. In power-driven line finder offices, the non-inductive winding of the (L) relay is not connected, in parallel with its inductive winding, during the time that the (L) relay is connected in series with the sub-station loop and the winding of the line finder (L) relay. This is to insure the (L) relay receiving sufficient current to operate under most circuit conditions. It also insures a quick release, so

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that the (L) relay releases, before the (S) relay operates, when the line is found. The release of the (L) relay, releases the (PR) relay and removes the short circuit from the winding of the (M) relay, which operates and is locked in series with the (K) relay. The release of the (PR) relay connects battery through the two 18-AJ resistances connected in parallel, in series with the winding of the pen register, make contact of the (H) relay, to common ground through the break contacts of the (PR) relay and (REL) key, starting the operation of the pen register. The operation of the (M) relay lights the (D) lamp, short-circuits the 1150 ohm winding of the (C) relay.

11. SENDER SELECTED

When the sender is selected, the (L) relay reoperates in series with the sender (L) relay and the subscriber's line. The operation of the (L) relay, (a) connects battery through the winding of the (P) relay, (N) relay normal, (A) and (S) relays operated, ("S" wiring) and also through the (M) and (YK) relays operated, to common ground on the armature of the (L) relay, operating the (P) relay, and (b) reoperates the (PP) relay stopping the pen register. The (C) relay may release when the sender is selected, as its 3000 ohm winding is then in parallel with the sender (L) relay. If the (C) relay releases, the (HL) relay holds through its 800 ohm winding and make contact, (A) and (S) relays operated and also through the (M) and (YK) operated relays, to common ground on the armature of the (L) relay. The operation of the (P) relay, (a) connects common ground to one winding of the (B) relay, to the winding of the (PO) relay and to the (S) lamp, all in parallel, operating the (B) and (PO) relays and lighting the (S) lamp, (b) stops cycle counter 1, and (c) closes a circuit through its winding and the winding of the (N) relay in series, make contact of the (P) relay, to common ground in which the (N) relay operates, and the (P) relay holds as soon as the short circuit is removed from the winding of the (N) relay by the release of the (L) relay. The (S) lamp lighted, indicates that a sender has been selected. The operation of the (B) relay releases the (C) relay, if it should be holding in parallel with the sender (L) relay, and disconnects the 18-BL resistance from the tip side of the line. The operation of the (PO) relay prevents the operation of the (PP) relay and the lighting of the (PP) lamp when the (HL) relay releases.

12. DIALING

When the subscriber starts dialing, the (L) relay releases and re-operates, in series with the sender (L) relay, each time the subscriber's line circuit is opened and closed by the dial. When the (L) relay releases from the first dial pulse, the (HL) and (PR) relays release, and

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the short circuit from the winding of the (N) relay is removed. The (N) relay now operates and the (P) relay holds in the circuit as described in paragraph 10. The (PR) relay releases and reoperates each time the (L) relay releases and reoperates. The pen register starts each time the (PR) relay releases and stops each time the (PR) relay operates, thereby recording the dial pulses corresponding to the number dialed. The (HL) relay released, removes the short circuit from the winding of the (D) relay which now operates and locks in series with the (E) relay. The operation of the (D) relay stops cycle counter 2 and connects ground through the other winding of the (B) relay.

13. SENDER SELECTED BEFORE THE CALLING LINE IS FOUND

Since the line finder circuit is so arranged that it hunts for an idle sender at the same time it is hunting for the calling line, the sender may be selected before the line is found. In this case, the service observing (L) relay does not release when the line is found as previously described, being held in series with the sender (L) relay. The (M) relay therefore does not operate until the short circuit is removed from its winding by the release of the (L) relay when the subscriber starts dialing. When the line is found after the sender is selected, the (SL), (S) and (P) relays operate as above described, stopping cycle counter 1, lighting the (S) lamp, and operating the (B) and (PO) relays.

14. PRELIMINARY IMPULSES

If the subscriber dials after the line has been found but before the sender is selected, the (C) relay releases, causing the release of the (HL) relay. The (HL) relay released, removes the short circuit from the winding of the (D) relay and connects battery through the winding of the (PP) relay and the (PP) lamp in parallel, the (PO) and (HL) relays, normal, the (E) relay operated, to common ground operating the (PP) relay, which locks and lights the (PP) lamp, indicating a preliminary impulse. The (D) relay now operates and the (E) relay holds as described in paragraph 13. The operation of the (D) relay stops cycle counter 2 and connects battery through one winding of the (B) relay which operates. The operation of the (B) relay prevents the reoperation of the (C) relay and disconnects the 18-BL resistance from the tip side of the line. The (FEL) key must now be operated to release the (PP) relay, extinguish the lamp, and disconnect the circuit from the line to which it is connected.

15. DISCONNECTION

When the (REL) key is operated, all the relays which were operated or locked to common ground through the break contacts of the (REL) key, release, and all lamps are extinguished. The operation of the (REL) key operates the (REL) relay. The (REL) relay operated, removes the short circuit from the winding of the (CL) relay and should the receiver be removed from the switchhook at this time (on an originating call) on any of the lines which are connected for observation, the (CL) relay operates from ground through its winding contacts of the receiver jacks, the service observing (L) relay operated, associated with this line, the (S) and (A) relays normal and inner winding of the (YK) relay associated with this line, the (J) relay normal, to battery through the inductive winding of the (F) relay. The (YK) and (F) relays do not operate in this circuit due to this high resistance of the (CL) relay. The operation of the (CL) relay locks the (REL) relay thus preventing the common ground from the contacts of the (REL) key from being connected to the armature of the (L) relays, until the time occurs when there are no originating calls being made on any of the lines connected for observation. When this condition exists (all (L) relays normal), the (CL) relay releases, in turn releasing the (REL) relay. The circuit is now ready for observation on the next call. It is necessary to operate the (REL) key and restore the circuit to normal after each observation.

OPERATION IN STEP-BY-STEP OFFICES

16. WHEN USED WITH PRIMARY AND SECONDARY LINE SWITCHES

In step-by-step offices equipped with both primary and secondary line switches, the operation is similar to that described for power-driven line finder offices, with the following exceptions: The (SL) relay is omitted and ("X" wiring) is used, the (S) terminal being connected to the private or sleeve terminal of the step-by-step line switch circuit. ("A" wiring) and the (MR) relay are used in place of ("B" wiring) and the (MR-1) relay. ("P" and "S" wiring) is used and ("M" and "N" wiring) is omitted. When the primary switch selects a trunk to the secondary switch, the (L) relay releases, thereby causing the service observing circuit to operate as described in paragraph 10, except that the (D) lamp indicates when the primary line switch plunges. When the secondary line switch plunges, the (L) relay reoperates, causing the service observing circuit to operate as described in paragraph 10. Since the primary and secondary line switches plunge rapidly, the (PO) relay is made slow to operate in order that the (PP) relay shall have sufficient time to operate in case of premature dialing. The (L) relay operated, shunts its inductive winding by its non-inductive winding, thereby making the relay slow to release, (but fast enough for dial

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pulses) in order that the time between the operation of the (L) relay and the plunging of the primary switch shall be long enough to insure the operation of the (YK) relay.

17. WHEN USED WITH PRIMARY LINE SWITCHES

In step-by-step offices equipped with primary line switches only, the ("N" wiring) is omitted and the ("S" wiring) is used. The operation is similar to that described in paragraph 16, except that the (S) relay operates when the primary switch plunges connecting battery through the winding of the (P) relay, the (N) relay normal, ("S" wiring), to common ground through the (A), (S) and (L) relays operated. The (P) relay operates in this circuit stopping cycle counter 1, operating the (B) and (PO) relays, and lighting the (S) lamp all as described in paragraph 10.

18. MISCELLANEOUS

18.1 Effect of Inductive Surges

When coin collect or coin return battery is connected to the line on a call from a coin station, the (CC) and (CC-1) or the (CR) and (CR-1) relays operate. Also, when coin collect battery is removed from the lines, the (CR) relay may operate due to the inductive kick from the coin magnet, or the (CC) may operate in case the coin return battery is removed from the line for same reason. Operation of the (CR) relay will provide a path for holding the (CC-1) relay, thus preventing the false lighting of the (CR) lamp. The (CC-1) relay is slow releasing, and has not had sufficient time to release between the release of the (CC) and the operation of the (CR) relay. When the inductive surge is over the (CR) relay will fall down, releasing the (CC-1) relay. The operation of the circuit when the coin return current is connected to the line is the same as described above for the coin collect battery, with the exception that the (CR-1) relay is operated and the operation of the (CC) relay by the inductive surge will hold the (CR-1) relay operated, thus preventing a false lighting from the CC lamp.

18.2 Coin Collect and Return

When coin collect battery is connected to the line on a call from a coin station, the (CC) relay operates, operating the (CC-1) relay, which opens the circuit for the (CR) lamp

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and closes battery through its secondary winding preparatory to locking under control of the (CR) relay when the inductive surge, which would otherwise result in a false operation of the (CR) relay and the resulting signal, occurs. (See paragraph 18.1). The (CC) relay also closes a circuit from ground on its armature, break contact of the (CR-1) relay, CC lamp to battery through the winding of the (MP) relay, operating the relay and lighting the lamp.

The same operation outlined above holds for the coin return battery, except that in the latter case the proper relays are operated. In either case the (MP) relay operates, operating the 4C buzzer, thus giving an audible signal in addition to the lighted CC or CR lamp. The (CC) or (CR) relays release when the coin collect or coin return circuit is opened, thereby extinguishing the lamp and releasing the (MP) relay.

19. MESSAGE REGISTER

19.1 Line Finder Offices

When a call originates at a message register line to which the service observing circuit is connected, the operation of the charge relay in the district circuit, at the completion of the call connects battery to the (MR) lead, operating the (MR-1) relay in parallel with the message register in the subscriber's line circuit. The operation of the (MR-1) relay closes and operates the (MP) relay and lights the (MR) lamp. The operation of the (MP) relay operates the 4-C buzzer. When battery is disconnected from the lead (MR), the (MR-1) relay releases, releasing the (MP) relay, stopping the buzzer and extinguishing the (MR) lamp.

19.2 Step-by-Step Offices

The operation is the same as for line finder offices, except that the (MR) relay is connected to the (MR) lead ("A" wiring) and operates instead of the (MR-1) relay when battery is connected to the (MR) lead.

19.3 Line Switch Offices

When the subscriber removes the receiver from the switchhook, the subscriber's line is locked into the observer. When a sender is connected to the line, the (P) relay operates, which causes the operation of the (PO) relay. The (PO) relay operated, connects

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the (MR-2) and (MRA) relays in parallel with the subscriber's message register and the cut-off relay. Battery from the (SL) relay in the district selector circuit flows through the (MR-2) and (MRA) relays and causes the operation of the (MRA) relay. The (MR-2) relay is a marginal relay and does not operate under this condition. The operation of the (MRA) relay operates the (MBRB) relay which prepares a path for the (MR) lamp. The (MRC) relay is a marginal relay and does not operate under this condition.

19.4 Call Not Charged

When the subscriber hangs up the receiver, on the completion of the call, the district selector circuit advances and disconnects the battery from the message register and cut-off relay and also from the (MRA) relay. The release of the (MRA) relay causes the operation of the (MRC) relay which opens the circuit to the (MRA) and (MR-2) relays. This arrangement prevents the false operation of the (MR-2) relay while the switch is returning to normal and the message register terminal is connected to battery on the idle districts. The (MRB) and (MRC) relays are locked up, to ground through the release key. The operation of the (MRC) relay operates the (MRD) relay which in turn short-circuits the (MRB) relay, releasing it and holding the (MRC) relay operated. The release of the (MRB) relay opens the circuit to the (MR) lamp. When the operator operates the release key, the relays release.

19.5 Call Charged

Under this condition when the subscriber hangs up, the current through the message register is increased to operate it. This increase in current also causes the operation of the (MR-2) relay and lights the (MR) lamp. The district circuit then releases and the (MRA) and (MR-2) relays release. The (MR-2) relay released, extinguishes the (MR) lamp which is a signal for the observing operator to release the circuit. The operation of the release key restores the circuit to normal.

19.6 Second Call Made Before Observing Circuit is Released

Under this condition the operation is the same as covered in 20.4 and 20.5, except that on the completion of the operation the observer does not operate the release key to release the (MRB) and (MRC) relays. The operation of the (MRC) relay

also closes a circuit to the (MRD) relay from the contact of the (N) relay. The (N) relay operates under this condition. When the subscriber removes the receiver from the switchhook to initiate a second call, the (L) relay operates which causes the operation of the (MRD) relay. The operation of the (MRD) relay short-circuits the winding of the (MRB) relay and causes its release. The (MRC) relay is held operated through the contacts of the (MRD) relay. When an idle district is found, the (L) relay releases, in turn releasing the (MRD) relay, which in turn allows the (MRC) relay to release and close the circuit to the (MR-2) and (MRA) relays. The circuit is then in condition to determine whether the second call is charged.

19.7 Flat Rate Lines

Under this condition, the (MRA), (MRB) and (MRC) relays operate, opening the circuit for the (MR-2) relay and the circuit functions as described in 20.4.

19.8 Flat Rate Lines With Message Rate Districts

Under this condition the circuit may function as described in 20.5. If so, the operator should be instructed to disregard the operation of the (MR) lamp on this class of call.

20. TESTING CYCLE COUNTERS

To test the cycle counters, the "COUNTER CHECK" key is operated, which connects common ground on the break contact of the (REL) key, contacts of the receiver jack, "COUNTER CHECK" key operated, to battery through the winding of the (Q) relay, which operates. The (Q) relay operated, (a) locks to common ground under control of the (REL) key, (b) disconnects the cycle counters from the regular circuit but closes a circuit through the "COUNTER CHECK" key starting the operation of the cycle counters, (c) operates the (B) and (PO) relays, and (d) lights the (S) lamp, as an indication that the (REL) key must be operated before the circuit can be used for observation on another call. When the "COUNTER CHECK" key is released, the circuit through the cycle counter is opened. When the (REL) key is operated, the (Q) relay releases, extinguishing the (S) lamp, and releasing the (B) and (PO) relays.

21. DISCONNECTION OF PEN REGISTERS

The operation of the PEN REGISTER CUT-OFF key, opens locking

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circuit for the (H) relay. In this case, the (H) relay operates when the (PR) relay operates as previously described, but when the (PR) relay releases, the (H) relay also releases, thus preventing the operation of the pen register.

22. HOLD AND TALK

The operation of the "Hold and Talk" key at any time, operates the (T) relay, lights the "Hold" lamp, connects the 46-A (or 47-A) retardation coil across the tip and ring of the service observing line, to prevent the disconnection of the line from the desk and connects the series observing operator's transmitter to the primary winding of the induction coil. The operation of the (T) relay connects the tip and ring of the service observing line to the secondary windings of the induction coil in series with the 21-E condenser, and connects the operator's receiver across the 478 ohm winding of the induction coil. The service observing operator can now talk to the subscriber and give instructions when necessary to remedy any trouble caused by the subscriber. When the "Hold and Talk" key is restored to normal, the (T) relay releases and the "Hold" lamp is extinguished.

23. TERMINATING CALLS

When a final selector selects and connects to the terminals of a line which is connected for observation, the (SL) relay operates, ("Y" wiring), causing the operation of the (S) relay. When a connector selects and connects to the terminals of a line which is connected for observation, the (S) relay operates ("X" wiring). In either case, the operation of the (S) relay prevents the operation of the associated (YK) relay when the called party removes the receiver from the switchhook, and the (L) relay operates.

24. SPARK REDUCTION

The 2 mf condenser and the 18-AC resistance decreases the spark at the contacts of the (L) relay, caused by the inductive discharges of the (PR) relay, and the 0.5 mf condenser and the 18-G resistance decreased the spark at the contacts of the (H) relay caused by the inductive discharges of the pen register. The two parallel 18-AJ resistances connected in series with the pen register are used in place of an equivalent single resistance, to decrease the heating effect.

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